

A NEW SPECIES OF *BRACHYCENTRUS CURTIS*
(TRICHOPTERA: BRACHYCENTRIDAE) FROM THE SOUTHERN
APPALACHIAN MOUNTAINS AND VARIATION IN THE CADDISFLY
B. SPINAE ROSS

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Abstract.—Description and illustrations for *Brachycentrus lunatus*, n. sp., from the southern Appalachian Mountains are provided. Intraspecific variation of larval color pattern previously has been noted among populations of the caddisfly *Brachycentrus spinae* Ross. We found a strong correlation between larval phenotype and geographical distribution. No significant adult variation was correlated with the larval *B. spinae* phenotypes.

Key Words: Trichoptera, Brachycentridae, *Brachycentrus*, *Brachycentrus spinae*, intra-specific variation, southern Appalachian Mountains

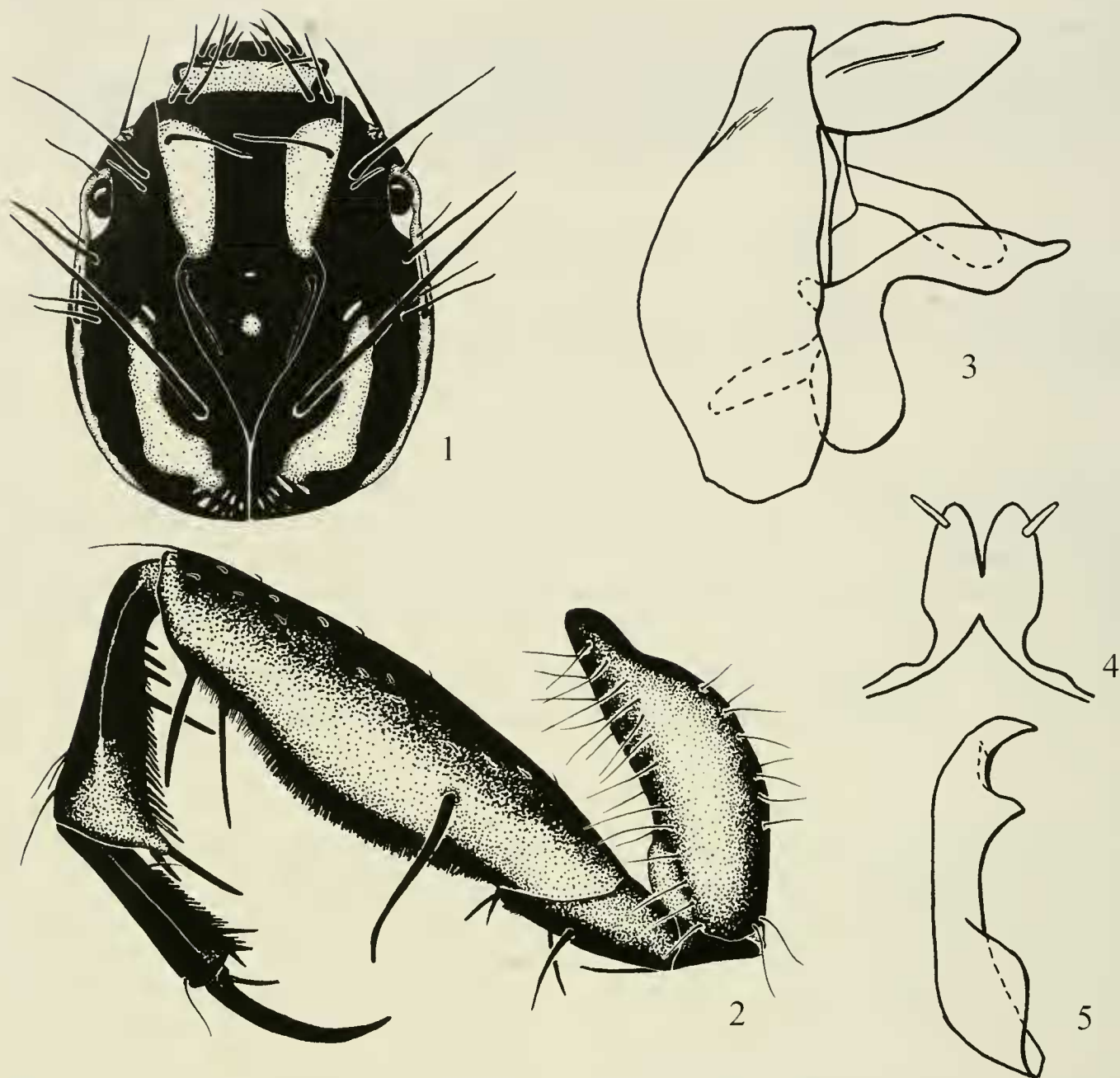
More than 11,000 species of Trichoptera have been described worldwide (Morse 2001). In North America, only about one-third of the continent's nearly 1,500 described Trichoptera species have larvae associated with their corresponding adults (Morse et al. 1997). Trichoptera larvae are known even more poorly in other major global regions (e.g., Morse 2002). Though numerous ecological studies have been conducted on Trichoptera species, most have focused on a single population or small number of populations, such that few species have been comprehensively investigated throughout their range. Comprehensive investigations would more likely provide information concerning geographical associations and life-history patterns.

The southern Appalachian caddisfly *Brachycentrus spinae* Ross exhibits considerable intraspecific variation. The original description was based entirely on adult males from one population (Ross 1948). When Flint (1984) associated larvae with adult *B. spinae*, he noted "perplexing" variation,

but concluded that the different phenotypes represented a single species, owing to a lack of reared material and no apparent significant variation among adults. Larval head capsules vary considerably. Head capsules of larvae from the type locality, hereafter referred to as "typical," have vivid yellow markings on the frontoclypeus and parietal sclerites (Fig. 6). Other larvae, hereafter referred to as "dark-headed," have uniformly dark brown or black head capsules that appear more nearly rounded (Fig. 7). Larval variation in *B. spinae* has continued to perplex benthologists and taxonomists, as intraspecific variation to this extent is not frequently documented among larval Trichoptera. The present study attempts to elucidate the perceived intraspecific variation of *B. spinae* and provides the description of a new *Brachycentrus* species.

METHODS

Material for this study was acquired from the Illinois Natural History Survey (INHS), Royal Ontario Museum (ROM), Virginia



Figs. 1–5. *Brachycentrus lunatus*. 1, Larval head, dorsal. 2, Larval left metathoracic leg, posterior/lateral view. 3–5, Male terminalia. 3, Genitalia, left lateral. 4, Tergum X, dorsal. 5, Left inferior appendage, postero-ventral.

Museum of Natural History (VMNH), and Virginia Tech Museum of Natural History (VTMNH) and fresh specimens were collected from streams throughout the southern Appalachian Mountains. Specimens were collected in 80% ethanol. Adult terminalia were cleared in a heated potassium hydroxide solution. Additional material and paratypes are deposited in the Clemson University Arthropod Collection, Clemson, SC (CUAC), and the National Museum of Natural History, Smithsonian Institution, Washington, DC (NMNH).

Brachycentrus (Sphinctogaster) lunatus
Harrington and Morse, new species
(Figs. 1–5)

Adult.—Length of body, including head and folded wings: 11–12 mm. *Color*: Wings brown, each with pale stigmal spot between radius and subcosta at distal margin. Sclerites fuscous to dark brown. *Male genitalia*: Preanal appendages elongate, tapered, and completely separate mesally in dorsal aspect. Tergum X divided into two lobes in dorsal aspect, each lobe rounded and narrowed apically, with one subapico-

dorsal macrochaeta projecting laterad. Inferior appendages broad basally, each projecting into sharp point directed mesad. In posteroventral aspect, mesal margin produced into subapical point, creating crescent-shaped margin between apical and subapical point.

Larva.—Length to 12 mm. Sclerites dark brown and fuscous, marked with pale yellowish bands; frontoclypeus dark with well-defined yellow spots anterolaterally and not extending to anterior margin; parietal sclerites dark, each with pale band posteriorly and between setae 16 and 17, parallel to coronal and frontoclypeal sutures; lateral pale band extending from eye to posterior margin. Femora of meso- and metathoracic legs dark dorsally, fading to yellow ventrally, their tibiae dark basally and pale distally; each tibia with three to four consecutively larger setae along basoventral margin.

Type material.—Holotype, ♂: Eastatoe Creek @ SR 100 (34.996733 N, 82.827783 W), Pickens Co., South Carolina. 20 April 2001, Coll: R.C. Harrington (INHS). Paratypes: Same collection data as holotype, 2 ♂ (CUAC), 3 ♂ (NMNH), R.C. Harrington.

Other material.—North Carolina, Henderson County, Green River at Bobs Creek Rd., 10 February 2002, 14 larvae, R. C. Harrington, D. R. Jones (CUAC); same locality but 29 March 2002, 1 larva, 1 pupa, R. C. Harrington (CUAC); same locality but 16 April 2002, 2 pupae, 1 metamorphotype, R. C. Harrington (CUAC); McDowell County, Old Fort, at bridge Northwest of town, 1 April 1971, 1 larva, J. C. Morse and F. Sherberger (CUAC). South Carolina, Pickens County, Eastatoe Creek @ State Route 100, 14 March 2001, 12 larvae, R. C. Harrington (CUAC); same locality but 8 March 2002, 12 larvae, R. C. Harrington (CUAC); Eastatoe Creek near highway 143, 15 February 1995, 1 larva, 1 pupa, Y. J. Li (CUAC); “Rocky Bottoms Creek @ SR-39-100” (actually Eastatoe Creek at SR 100), 1 April 76, 1 pupa, J. W. Chapin (CUAC).

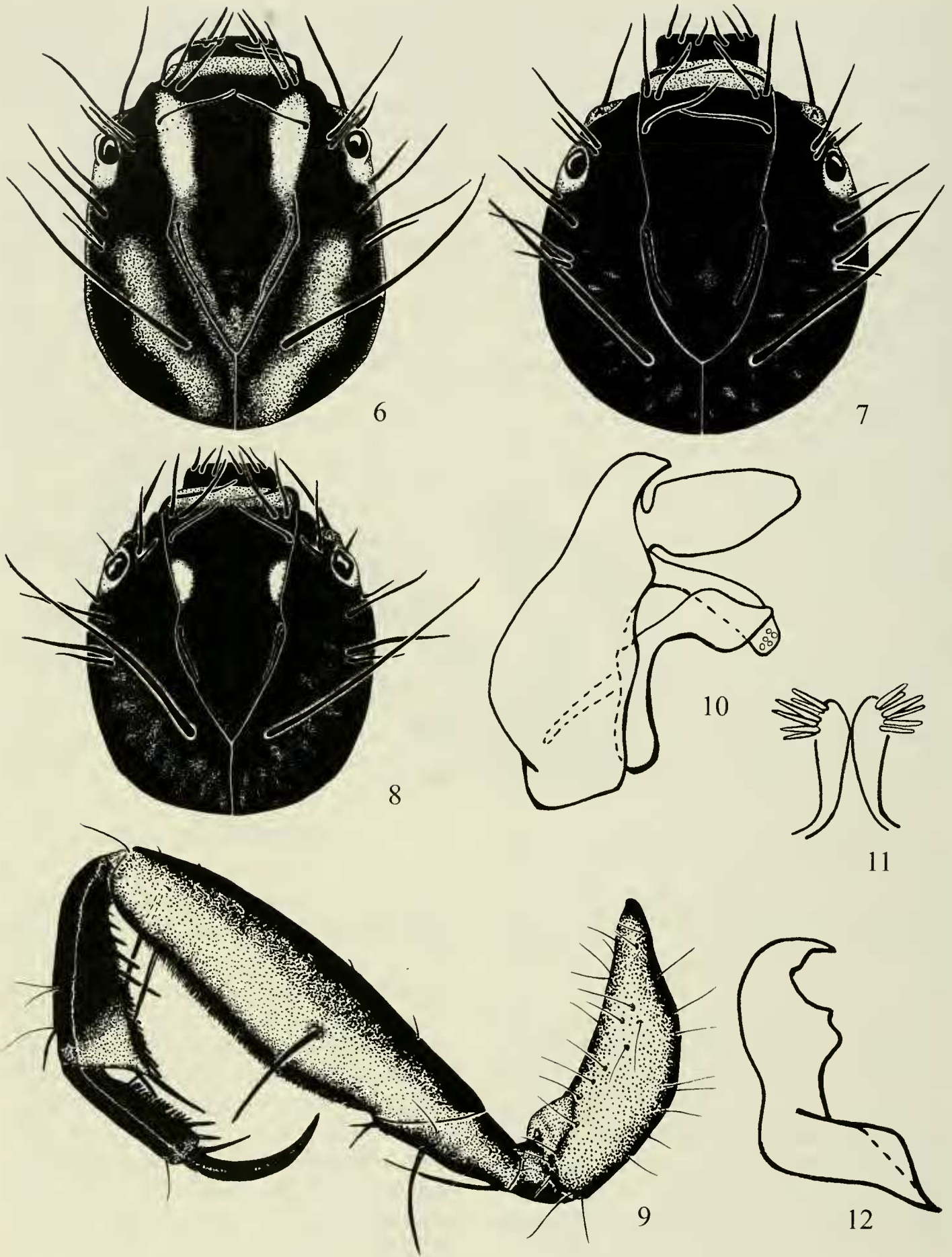
Diagnosis.—Male genitalia of this species are very similar to those of *Brachycentrus spinae* in the shape of the inferior appendages and tergum X. Only one macrochaeta is present, however, on each lobe of tergum X (as opposed to numerous macrochaetae for *B. spinae*) and the subapical protuberance of each inferior appendage produces only a sharp point and lacks the more basal rounded portion present in *B. spinae*. Larvae of this species are also very similar to those of *B. spinae* but can be distinguished by the clearly defined pale markings on the frontoclypeal and parietal sclerites (as opposed to the less clearly defined pale markings on the frontoclypeal and parietal sclerites of *B. spinae*).

Etymology.—*lunatus* (Latin) = crescent shaped, referring to the general appearance of the apical end of each inferior appendage.

Notes.—This species is a member of the *Brachycentrus numerosus* species group (Flint 1984) and appears to be a sister species of *Brachycentrus spinae* Ross. It has been collected only from streams in upper Atlantic Coast drainages of the Appalachian Mountains.

Brachycentrus spinae Ross
(Figs. 6–12, 13)

Populations of *Brachycentrus spinae* were encountered throughout the entire southern Appalachians, conforming almost completely to the southern Appalachian ecoregion (Fig. 13). “Typical” larvae (Fig. 6) were distributed along the western edge of the Appalachians, primarily along the Tennessee–North Carolina border, and in North Carolina in the vicinity of the Tennessee–Virginia border. Uniformly dark-headed individuals (Fig. 7) were found throughout the interior southern Appalachians of North Carolina and northern Georgia. About 80% of dark-headed populations had specimens with a mottled appearance due to muscle scars along the posterior portion of the parietal sclerites. The degree of darkening also varied among pop-



Figs. 6-12. *Brachycentrus spinae*. 6-8, Larval heads, dorsal view. 6, "Typical" larva (from type locality—Camp Creek, Greene County, Tennessee). 7, "Dark-headed" larva from French Broad River (Transylvania County, North Carolina). 8, "Intermediate" larva from Rock Creek (Fannin County, Georgia). 9, Larval left metathoracic leg, lateral view (from type locality—Camp Creek, Greene County, Tennessee). 10-12, Male terminalia. 10, Genitalia, left lateral. 11, Tergum X, dorsal. 12, Left inferior appendage, posteroventral.

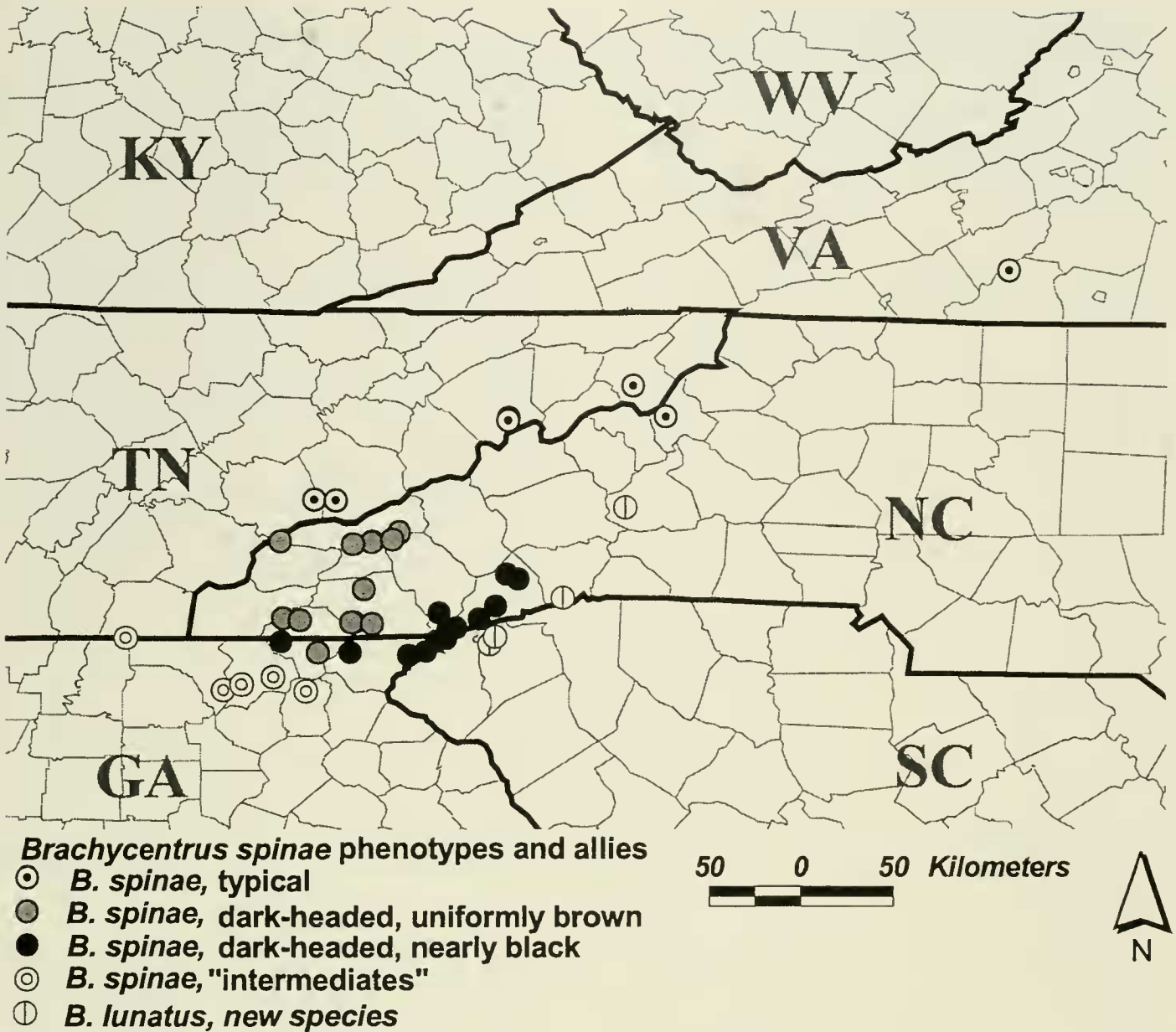


Fig. 13. Distribution of *Brachycentrus spinae* larval phenotypes and *Brachycentrus lunatus*.

ulations, ranging from uniformly brown to nearly black. A cluster of populations from northern Georgia presented an intermediate larval color pattern. These intermediates possessed nearly completely dark head capsules with small pale markings on the frontoclypeus and parietal sclerites (Fig. 8).

Not all populations were sampled in both the larval and adult stages. However, for those population for which adults were associated with larvae, adults that we consider *B. spinae* did not exhibit differences or trends distinct enough to warrant description. In general, adults from both the dark-headed and typical populations possessed numerous macrochaetae on each lobe of tergum X (Fig. 1). Also, inferior append-

ages from adults of both larval phenotypes had the same general appearance: a sharp apical point, a subapical point, and more basal "chin-like" protuberance (Fig. 12). On the other hand, although larvae of populations along the eastern Blue Ridge Escarpment bore a strong resemblance to typical populations of *B. spinae*, consistent differences in larval and adult characters provide evidence that they represent a distinct species described above.

Variation has been reported for several other Trichoptera, including *Hesperophylax* species (Parker and Wiggins 1985), *Rhyacophila nigrita* Banks (Prather and Morse 2001), *Arctopsyche grandis* (Banks) (Hauer and Stanford 1981), *Hydropsyche contuber-*

nalis McLachlan (Guinand et al. 1997), *Diplectrona modesta* Banks (Morse and Barr 1990), and *Cheumatopsyche harwoodi enigma* Ross, Morse, and Gordon (Gordon 1974). Despite the observed moderate larval or adult morphological variation in each situation, none of these studies concluded that multiple, distinct species exist. The unusual contrast between dark-headed and typical larvae of *Brachycentrus spinae* strongly suggested a complex of at least two species. From among the larval phenotypes that we eventually segregated, only *B. lunatus* had corresponding diagnostic characters in males. We found no corresponding adult characters to discriminate the other phenotypes in the adult form. Furthermore, the larval forms are allopatric, preventing inferences about natural reproductive isolation. The typical phenotype is restricted to the western edge of the southern Appalachians, the dark-headed phenotype in the interior southern Appalachians (with the darkest larvae occurring in the southern and eastern parts of the range), and "intermediates" in the extreme southern extent of the range (Fig. 13).

The taxonomic significance of "intraspecific" variation between dark and typical *Brachycentrus spinae* remains open to investigation, particularly one that uses a molecular population genetics approach. Other studies on organisms inhabiting the southern Appalachians have also found patterns of substantial variation that correlate with geography (e.g., Nalepa et al. 2002). The orientation and situation of the southern Appalachians might have once provided a refuge for northern species and served to fragment populations of less mobile southern species during peaks of Pleistocene glaciation (Hack 1969). We suspect that *Brachycentrus spinae* has low vagility in its adult phase due to its ephemeral adult life span and therefore may be a species that is particularly vulnerable to range fragmentation.

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